NON-PUBLIC?: N
ACCESSION #: 9412010251
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Calvert Cliffs, Unit 2 PAGE: 1 OF 7

DOCKET NUMBER: 05000318

TITLE: Reactor Shutdown Due to Turbine Trip Caused by Improperly Installed Link
EVENT DATE: 10/27/94 LER #: 94-006-00 REPORT DATE: 11/23/94

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: D. W. Muth, Compliance Engineer TELEPHONE: (410) 260-3592

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On Thursday, October 27, 1994 at about 2353 hours, Calvert Cliffs Unit 2 tripped on receipt of a Reactor Protective System Loss of Load signal. Investigators found that a ground had been caused by the "A" phase Main Generator transition links, which were damaged by overheating after having been installed incorrectly.

The root cause of this event was failure to adequately address the potential risks of work newly assumed by the Electrical Maintenance group.

New links were correctly installed and the Unit was brought back on line. Since the time the links were installed, improvements have been made to our Maintenance processes. These existing practices will be reviewed in light of the circumstances of this event to verify their adequacy.

END OF ABSTRACT

I. DESCRIPTION OF EVENT

On Thursday, October 27, 1994 at about 2353 hours, Calvert Cliffs Unit 2 was operating in MODE 1 at normal operating pressure and temperature when the reactor tripped on receipt of a Reactor Protective System Loss of Load signal. The signal resulted from a Main Turbine trip on actuation of the Main Generator Differential and Ground lockout relay. Neither the Engineered Safety Features nor the Auxiliary Feedwater Actuation Systems actuated since their setpoints were not reached. Post-Trip Immediate Actions were performed in accordance with Emergency Operating Procedure (EOP)-0 and completed satisfactorily with all Safety Functions within acceptance criteria.

During the performance of EOP-0, Control Room personnel received reports of a burning smell near the Unit 2 Main Turbine Generator. They also noted unanticipated alarms of "Main Gen Diff/Gnd," and "Core Monitor." The required actions of EOP-0 and EOP-1, Reactor Trip, were completed with all safety functions within acceptance criteria.

A Significant Incident Finding Team was organized to investigate the circumstances and root causes of this event. Investigators found severe damage to the "A" phase Generator transition links to the isolated phase bus bars. Further inspections and testing indicated no damage to the generator itself, to the Unit step-up transformers, nor to the isolated phase bus duct.

The Main Generator output runs to each of three isolated phase bus bars via a transition assembly connected from the generator high voltage bushing to the isolated phase bus bushing. The transition assembly on each phase consists of eight flexible copper links joined by six bolts each to solid copper adapter plates attached to the generator high voltage bushing above and solid copper connectors running to the isolated phase bus bushing below (see Figure 1). Each flexible link consists of fifty thin copper plates laminated together and is coated with black paint, leaving only the connecting surface bare and coated initially with silver. Each link also has an omega-shaped bend which allows for expansion. The links are attached to the adapter plate by bolts which are significantly smaller in diameter than the holes in the adapter plate. As a result, when the bolts are torqued down, the copper mating surface on each link is extruded into the adapter bolt holes while the surface of the connector develops an indentation (see Figure 2).

Investigators who opened the Isolated Phase Bus Duct covers found all of the "A" phase transition links and adapter plates severely damaged while the "B" and "C" phases were unaffected. The damaged "A" phase equipment was removed for analysis. Materials analysis of the remnants of the "A" phase transition links revealed that they had been installed backwards, the painted side of the links being attached to the adapter plate. This resulted in a high resistance connection due to a combination of contact area reduction and poor contact

surface conductivity characteristics. Since the links had been previously installed correctly and indentations formed in both surfaces, reversal of the links resulted in a decrease in contact area. As the assembly heated up during operation, the link indentations relaxed,

causing a loosening of the bolted connection, increasing resistance. The contact surface of each link is supposed to be coated with silver. The back of the link is not. The lack of silver, combined with the paint, reduced the conductivity of the surface. This, combined with the loosened connection resulted in some links not carrying sufficient current, overloading others. The overloaded links gradually oxidized, embrittled, and broke. This overloaded the remaining links, which failed due to overheating.

On November 4, 1994, new links were correctly installed and the Unit was brought back on line the following day.

II. CAUSE OF EVENT

The root cause of this event was failure to adequately address the potential risks of work newly assumed by the Electrical Maintenance group. Electrical Maintenance supervision assumed that the bolting was within the skill of the craft and gave no additional guidance or oversight beyond that provided for routine maintenance. The planner made no mention of the need for proper orientation of the links in the work package. He referenced the drawing that showed proper orientation of the links, but did not include it in the package. The workers installing the links did not refer to the drawing to verify correct installation.

Main Generator transition links are removed every outage. Prior to the last Unit 2 refueling outage, in 1993, this work had been performed by the Electrical Modifications group of the Electrical and Controls Maintenance organization. In December 1993, Electrical Maintenance, a separate group in the same organization, assumed responsibility for this work. The Assistant General Supervisor, Electrical Maintenance believed

his personnel had the requisite skills to perform the work since he assumed that connecting up the links was a matter of "ordinary bolting."

An Electrical Modifications planner experienced with this job was assigned to assist in planning the work. His effectiveness, however, was hampered by differences in work planning methods between the two groups. The Electrical Maintenance planner adapted an old Modifications Electrical MO for this work to the format currently used in his organization. The job step for installing the links in the original MO required the use of a drawing showing the proper orientation of the links. The drawing was not included in the new MO package but rather was listed in an introductory section as information to which the craftsmen may refer at their discretion. The Electrical Maintenance planner

was not familiar with the work and was not aware of the importance of the orientation of the links.

The links were removed on February 24, 1993. The "A" phase links were installed on May 31, 1993 and the "B" and "C" phases were installed by separate crews on June 1, 1993. None of the three crews installing the links had been involved in the removal of the links nor had any previous experience installing or removing the links. The first crew, which installed the "A" phase links, was unaware both of the proper bolting orientation and the importance of proper bolting orientation. Since both sides of the "A" phase links had been thoroughly cleaned, they were unable to tell that only one side was intended to make electrical contact. The workers assumed that either side would be acceptable. None of the workers in any of the three crews reviewed the drawing referenced in the MO which showed the proper orientation of the transition links.

III. ANALYSIS OF EVENT

There were no safety consequences associated with this event. The plant tripped as expected when the loss of load signal was received. Performance of the plant was within the assumptions of the safety analysis.

This item is reportable under the provisions of 10 CFR 50.73(a)(2)(iv) as a Reactor Protective System actuation.

IV. CORRECTIVE ACTIONS

A. New links were correctly installed and Unit 2 was brought back on line.

B. Unit 1 was reviewed for similar conditions. The circumstances of the reconnection of the Unit 1 links are such that we are confident that they are installed correctly. We will monitor the temperature of the Unit 1 link box ventilation ports. Unit 1 links will be examined during the next Unit 1 outage as a precautionary measure.

C. Appropriate personnel actions will be taken.

D. This event will be reviewed with Maintenance personnel, including Maintenance Planners, to emphasize the importance of self-checking and a questioning attitude.

E. The activities which caused this event took place over a year and a half ago. Since that time, various improvements have been made to our Maintenance processes. These processes include supervisory coaching, work planning, self checking, and pre-job briefs. These existing practices will be reviewed in light of the circumstances of this event

to verify their adequacy. In addition, we will formalize the process of turning over a task between different groups and evaluate the need for face-to-face work turnovers and second verification of electrical connections.

V. ADDITIONAL INFORMATION

A. Affected Component Identification:

IEEE 803 IEEE 805
Component or System EIIS Funct System ID

Main Generator Lockout Relay 86 EL
Flexible Transition Link FCON EL
Isolated Phase Bus Duct BDUC EL
Generator GEN EL

B. Previous Similar Events:

There have been two events reported via Licensee Event Report involving a Loss of Load trip caused by maintenance performance problems. LER 50-317/88-006 involved a turbine trip caused by maintenance personnel improperly isolating level switches on the 12 Feedwater Heater due to an unclear maintenance procedure. LER

50-318/88-002 describes a loss of load trip caused by loss of Instrument Bus 22 due to an electrician misinterpreting electrical prints and unclear communications during troubleshooting. Neither event involved improper installation of equipment or change management problems.

Figure 1 "MAIN GENERATOR TRANSITION ASSEMBLY" omitted.

Figure 2 "FLEXIBLE LINK BOLTING DETAIL (not to scale)" omitted.

CHARLES H. CRUSE
Plant General Manager
Calvert Cliffs Nuclear Power Plant

Baltimore Gas and Electric Company
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, Maryland 20657
410 586-2200 Ext. 4101 Local
410 260-4101 Baltimore

November 23, 1994

BGE

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 2; Docket No. 50-318; License No. DPR 69
Licensee Event Report 94-006
Reactor Shutdown Due to Turbine Trip Caused by Improperly Installed Link

The attached report is being sent to you as required under 10 CFR 50.73 guidelines. Should you have any questions regarding this report, we will be pleased to discuss them with you.

Very truly yours,

CHC/DWM/bjd

Attachment

cc: D. A. Brune, Esquire
J. E. Silberg, Esquire
L. B. Marsh, NRC
D. G. McDonald, Jr., NRC
T. T. Martin, NRC
P. R. Wilson, NRC
R. I. McLean, DNR
J. H. Walter, PSC
Director, Office of Management Information
and Program Control

*** END OF DOCUMENT ***